Global Hydrology Resource Center

Data User Guide

Autonomous Parsivel Unit (APU) IMPACTS

Introduction

The Autonomous Parsivel Unit (APU) IMPACTS data were collected in support of the Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS) campaign. The IMPACTS field campaign addressed providing observations critical to understanding the mechanisms of snowband formation, organization, and evolution, examining how the microphysical characteristics and likely growth mechanisms of snow particles vary across snowbands, and improving snowfall remote sensing interpretation and modeling to significantly advance prediction capabilities. This dataset consists of precipitation data including precipitation amount, precipitation rate, reflectivity in Rayleigh regime, liquid water content, drop diameter, and drop concentration. Data are available in ASCII format from January 15, 2020 through February 29, 2020.

Citation

Tokay, Ali, David B. Wolff, and Charanjit S. Pabla. 2020. Autonomous Parsivel Unit (APU) IMPACTS [indicate subset used]. Dataset available online from the NASA EOSDIS Global Hydrology Resource Center Distributed Active Archive Center, Huntsville, Alabama, U.S.A. doi: http://dx.doi.org/10.5067/IMPACTS/APU/DATA101

Keywords:

NASA, GHRC, IMPACTS, APU, Parsivel, precipitation, precipitation rate, precipitation amount, droplet size, hydrometeors, liquid precipitation, drizzle, rain, liquid water equivalent

Campaign

The Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS), funded by NASA's Earth Venture program, is the first comprehensive study of East Coast snowstorms in 30 years. IMPACTS will fly a complementary suite of remote sensing and in-situ instruments for three 6-week deployments (2020-2022) on NASA's ER-2 high-altitude aircraft and P-3 cloud-sampling aircraft. The first deployment began on January 17, 2020 and ended on March 1, 2020.

IMPACTS samples U.S. East Coast winter storms from advanced radar, LiDAR, and microwave radiometer remote sensing instruments on the ER-2 and state-of-the-art microphysics probes and dropsonde capabilities on the P-3, augmented by ground-based radar and rawinsonde data, multiple NASA and NOAA satellites (including GPM, GOES-16, and the Joint Polar Satellite System (JPSS)), and computer simulations. IMPACTS addressed three specific objectives:

(1) Provide observations critical to understanding the mechanisms of snowband formation, organization, and evolution;

(2) Examine how the microphysical characteristics and likely growth mechanisms of snow particles vary across snowbands;

(3) Improve snowfall remote sensing interpretation and modeling to significantly advance prediction capabilities.

More information is available from [NASA's Earth Science Project Office's IMPACTS field campaign webpage](https://espo.nasa.gov/impacts).

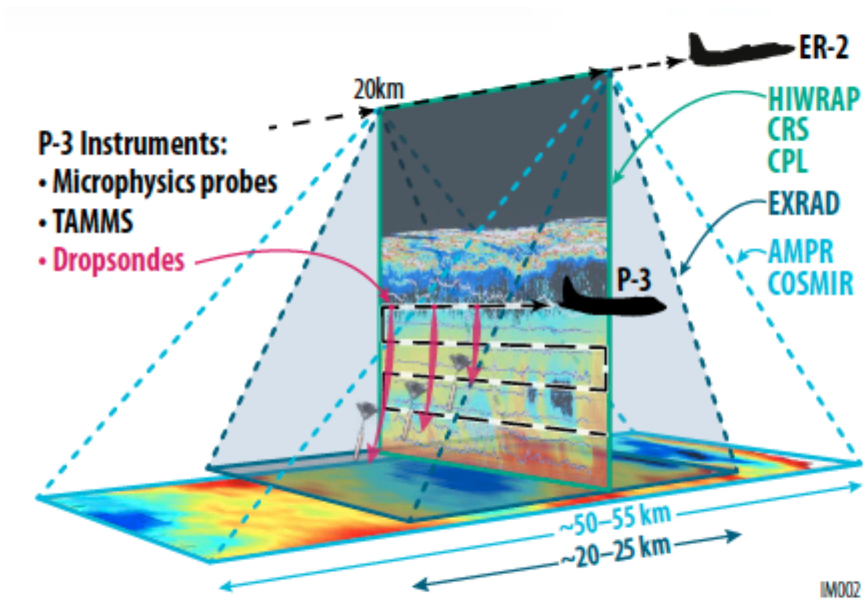

Figure 1: IMPACTS airborne instrument suite.
(Image Source: https://espo.nasa.gov/impacts)

Instrument Description

The Autonomous Parsivel Unit (APU) is an optical laser-based disdrometer that uses single-particle extinction to measure particle size and fall velocity. The APU used for the IMPACTS campaign consists of the Parsivel² and supporting hardware to allow for automatic data reporting.

The Parsivel² disdrometer produced by OTT Hydromet is a modern, laser-based optical system for measuring all types of precipitation. The transmitter unit of the sensor generates a flat, horizontal strip or sheet of light, in which the receiver converts into an electrical signal. When no particles pass through the horizontal beam, the maximum voltage is detected at the receiver. The signal changes whenever a hydrometeor falls through the sheet of light anywhere within the measurement area. The blocked portion of the laser signal results in reduced voltage output. The degree of dimming is a measure of the size of the hydrometeor and, together with the duration of the blockage, the fall velocity can be derived. The Parsivel² can also classify precipitation particles into 32 separate size classes and 32 velocity classes. Further information on the Parsivel² can be found at OTT Parsivel² Fact Sheet and Tokay et al., 2014.

This dataset consists of precipitation data collected from 13 APUs positioned in support of the IMPACTS field campaign. Table 1 lists the locations of these APU sites.

Table 1: IMPACTS APU sites

Site ID	Latitude (°)	Longitude (°)
apu01	37.9290	-75.4737
apu04	37.9346	-75.4710
apu05	38.0977	-75.4316
apu07	37.9345	-75.4708
apu08	38.0675	-75.5794
apu11	37.9442	-75.4638
apu15	37.9372	-75.4812
apu17	37.9444	-75.4812
apu18	37.9376	-75.4561
apu20	38.1964	-75.3688
apu21	38.1003	-75.5524
apu23	38.0140	-75.4549
apu25	38.0564	-75.4097

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Data Characteristics

The Autonomous Parsivel Unit (APU) IMPACTS data are available in ASCII format at a L3 data processing level. More information about the NASA data processing levels are available here.

Table 2: Data Characteristics

Characteristic	Description
Platform	Ground station
Instrument	Autonomous Parsivel Unit (APU)
Spatial Coverage	N: 38.206, S: 37.919, E: -75.359, W: -75.589 (Maryland)
Spatial Resolution	point
Temporal Coverage	January 15, 2020 - February 29, 2020
Temporal Resolution	One file per site, each site had various operation periods
Sampling Frequency	10 seconds integrated to 1 minute
Parameter	Precipitation amount, precipitation rate, reflectivity in Rayleigh regime, liquid water content, drop diameter, and drop concentration
Version	1
Processing Level	3

File Naming Convention

The Autonomous Parsivel Unit (APU) IMPACTS dataset consists of ASCII data files with the file naming conventions shown below.

Data files: impacts_<inst>_<parameter>.txt

Table 3: File naming convention variables

Variable	Description
<inst>	instrument/site name
<parameter>	data, dropcounts_min, flakecounts_min, raindsd_min, raindsd_min_ter, rainevent, rainparameter_min, rainparameter_min_ter, diameter, matrix*

.txt	ASCII text format

*More information about each parameter can be found in the *Data Format and Parameters* section below.

Data Format and Parameters

The Autonomous Parsivel Unit (APU) IMPACTS dataset consists of precipitation, precipitation amount, precipitation rate, reflectivity in Rayleigh regime, liquid water content, drop diameter, and drop concentration measurements. There are 14 files per parsivel site. Tables 4-8 describe how these measurements are organized in each file, as well as their units.

impacts_parsivel_diameter.txt files:

These files have four columns shown in Table 4. Terminal fall speed is estimated following Beard, 1976. Since Beard, 1976 do not extend to drops larger than 6.0 mm, terminal fall velocities for drops above 6.0 mm in diameter (bins 22-32) are subject to error. Therefore, a linear interpretation has been performed for the drops larger than 6.0 mm in diameter instead of following Beard, 1976.

Table 4: Data fields in impacts_parsivel_diameter.txt files

Column	Description	Unit
1	Drop shape corrected mid-bin size diameters	mm
2	Corresponding bin width	mm
3	Corresponding terminal fall speed following Beard, 1976	m/s
4	Corrected mid-bin fall velocities	m/s

impacts_parsivel_matrix.txt files:

These files are a 32 x 32 matrix that corresponds to the drop size and fall velocities of the manufacturer output. These files screen the drops following ±50% of its terminal fall speed. If the drop's fall velocity is outside the ±50% of its terminal fall speed, it is regarded as a secondary drop and eliminated from the processing. The matrix consists of "1" for accepted and "0" for rejected drops. This matrix is used for rain only. A fall velocity based threshold matrix is used for snow.

As part of the data processing, the 10-second observations are integrated into 1-minute; however, the timestamp of the 10-second observations has been documented in a file to distinguish the non-rainy periods from non-data collection periods. It should be noted that the thresholds of 10 drops and 0.01 mm/h have been applied to 1-minute observations to eliminate noise from rainy minutes.

impacts_<inst>_data.txt files:

These data files provide the existing database. They consist of 5 to 10 columns: year, day of the year, hour, minute, and seconds (6 columns maximum from 0 to 50). The files at one-minute resolution do not contain a 'seconds' column.

impacts_<inst>_dropcounts_min.txt files:
These files provide the total number of drops at each bin size at 1-minute integration. The files consist of 36 columns: year, day of the year, hour, minute, and 32 size bin drop counts.

impacts_<inst>_rainparameter_min.txt files:
These files are designed to present the integral rain parameters based on *measured* fall velocities at 1-minute integration. The files consist of 11 columns described in Table 5. It should be noted that four of these rain parameters (total concentration, liquid water content, reflectivity in Rayleigh regime, and mass-weighted drop diameter) require fall speed information in their formulations. More information on the disdrometer-based calculation of integral rain parameters can be found in Tokay et al., 2001.

Table 5: Data fields in impacts_<inst>_rainparameter_min.txt files

Column	Description	Unit
1	Year	-
2	Day of the year	-
3	Hour	UTC
4	Minute	UTC
5	Total number of drops	-
6	Total concentration	drops/m^3 of air
7	Liquid water content	g/m^3
8	Rain rate	mm/h
9	Reflectivity in Rayleigh regime	dBZ
10	Mass-weighted drop diameter	mm
11	Maximum drop diameter	mm

impacts_<inst>_rainparameter_min_ter.txt files:
These files provide the integral rain parameters based on *terminal* fall velocities at 1-minute integrations. The files consist of 11 columns described in Table 6.

Table 6: Data fields in impacts_<inst>_rainparameter_min_ter.txt files

Column	Description	Unit
1	Year	-
2	Day of the year	-
3	Hour	UTC
4	Minute	UTC
5	Total number of drops	-
6	Total concentration	drops/m^3 of air
7	Liquid water content	g/m^3
8	Rain rate	mm/h
9	Reflectivity in Rayleigh regime	dBZ
10	Mass-weighted drop diameter	mm
11	Maximum drop diameter	mm

impacts_<inst>_raindsd_min.txt files:

These files provide the raindrop size distribution based on *measured* fall velocities at 1-minute integrations. The files consist of 36 columns: year, day of the year, hour, minute, and 32 bin raindrop size distribution in drops $m^{-3}mm^{-1}$.

impacts_<inst>_raindsd_min_ter.txt files:
These files provide raindrop size distribution based on *terminal* fall velocities at 1-minute integration. The files consist of 36 columns: year, day of the year, hour, minute, and 32 bin raindrop size distribution in drops $m^{-3}mm^{-1}$.

impacts_<inst>_snowdsd_min.txt
These files provide the snowdrop size distribution based on *measured* fall velocities at 1-minute integrations. The file consists of 35 columns: year, day of the year, hour, minute, and 32 bin snow size distribution in drops $m^{-3}mm^{-1}$.

impacts_<inst>_rainevent.txt:
These files provide the rain event summaries. The events are separated by 1 hour or more rain-free periods in rain rate time series. The events that are less than 3 minutes or the rain total is less than 0.1 mm are not included. The files have 9 columns described in Table 8.

Table 8: Data fields in impacts_<inst>_rainevent.txt files

Column	Description	Unit
1	Year	-
2	Event start day of the year	-
3	Event start hour and minute	UTC
4	Event end day of the year	-
5	Event end hour and minute	UTC
6	Event rain minutes	-
7	Event maximum rain rate	mm/h
8	Event rain total	mm
9	Event maximum drop diameter	mm

Algorithm

All APU observations were processed for using a rain algorithm that uses the *impacts_<inst>_matrix.txt* file for accepting or rejecting particles.

Quality Assessment

All APU observations were processed for using a rain algorithm that uses the *impacts_<inst>_matrix.txt* file for accepting or rejecting particles.

The *impacts_parsivel_matrix.txt* files screen the drops following ±50% of its terminal fall speed. If the drop's fall velocity is outside the ±50% of its terminal fall speed, it is regarded as a secondary drop and eliminated from the processing. The matrix consists of "1" for accepted and "0" for rejected drops. As part of the data processing, the 10-second observations are integrated into 1-minute; however, the timestamp of the 10-second observations has been documented in a file to distinguish the non-rainy periods from non-data collection periods. It should be noted that the thresholds of 10 drops and 0.01 mm/h have been applied to 1-minute observations to eliminate noise from rainy minutes.

For *impacts_<inst>_diameter.txt* files, it should be noted that terminal fall velocities for drops above 6.0 mm in diameter (bin 22 through bin 32) are subject to error since Beard, 1976 do not extend for the drops larger than 6.0 mm. Therefore alinear interpretation has been performed for the drops larger than 6.0 mm in diameter instead of following Beard, 1976.

Software
No software is required to read these ASCII data files.

Known Issues or Missing Data
There are no known issues in this dataset.

References
Beard, K. V. (1976). Terminal Velocity and Shape of Cloud and Precipitation Drops Aloft, *Journal of the Atmospheric Sciences*, 33, 851-864. doi: https://doi.org/10.1175/1520-0469(1976)033<0851:TVASOC>2.0.CO;2

Tokay, Ali, Anton Kruger, and Witold F. Krajewski (2001). Comparison of Drop Size Distribution Measurements by Impact and Optical Disdrometers, *Journal of Applied Meteorology*, 40, 2083-2097. doi: https://doi.org/10.1175/1520-0450(2001)040<2083:CODSDM>2.0.CO;2

Tokay, Ali, David B. Wolff, and Walter A. Petersen (2014). Evaluation of the New Version of the Laser-Optical Disdrometer, OTT Parsivel^2, *Journal of Atmospheric and Oceanic Technology*, 31, 1276-1288. doi: https://doi.org/10.1175/JTECH-D-13-00174.1

Related Data
All data from other instruments collected during the IMPACTS field campaign are related to this dataset. Other IMPACTS campaign data can be located using the GHRC HyDRO 2.0 search tool.

In addition, other related data used the APU instrument in previous GPM Ground Validation field campaigns:

GPM Ground Validation Raw Autonomous Parsivel Unit (APU) IFloodS (http://dx.doi.org/10.5067/GPMGV/IFLOODS/APU/DATA401)

GPM Ground Validation Autonomous Parsivel Unit (APU) ICE POP
(http://dx.doi.org/10.5067/GPMGV/ICEPOP/APU/DATA101)

GPM Ground Validation Autonomous Parsivel Unit (APU) LPVEx
(http://dx.doi.org/10.5067/GPMGV/LPVEX/APU/DATA301)

GPM Ground Validation Autonomous Parsivel Unit (APU) GCPEx
(http://dx.doi.org/10.5067/GPMGV/GCPEX/APU/DATA301)

GPM Ground Validation Autonomous Parsivel Unit (APU) MC3E
(http://dx.doi.org/10.5067/GPMGV/MC3E/APU/DATA301)

GPM Ground Validation Autonomous Parsivel Unit (APU) HyMeX
(http://dx.doi.org/10.5067/GPMGV/HYMEX/APU/DATA301)

GPM Ground Validation Autonomous Parsivel Unit (APU) Wallops Flight Facility (WFF)
(http://dx.doi.org/10.5067/GPMGV/WFF/APU/DATA101)

GPM Ground Validation Autonomous Parsivel Unit (APU) OLYMPEX
(http://dx.doi.org/10.5067/GPMGV/OLYMPEX/APU/DATA301)

GPM Ground Validation Autonomous Parsivel Unit (APU) IFloodS
(http://dx.doi.org/10.5067/GPMGV/IFLOODS/APU/DATA301)

GPM Ground Validation NASA Autonomous Parsivel Unit (APU) IPHEx
(http://dx.doi.org/10.5067/GPMGV/IPHEX/APU/DATA301)

GPM Ground Validation Autonomous Parsivel Unit (APU) NSSTC
(http://dx.doi.org/10.5067/GPMGV/NSSTC/APU/DATA201)

Contact Information

To order these data or for further information, please contact:

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